

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**



HIGH PERFORMANCE THERMOPLASTIC RUBBER

SEPTONTM



KURARAY CO., LTD.
SEPTON Company of America
KURARAY EUROPE GMBH

CONTENTS

What is SEPTON® ? Unique and Versatile Polymer	1
SEPTON® Types and Properties	2
SEPTON® High Performance Thermoplastic Rubber	3
SEPTON® Basic Characteristics	7
SEPTON® Applications	9

What is SEPTON® ?

Unique and Versatile Polymer

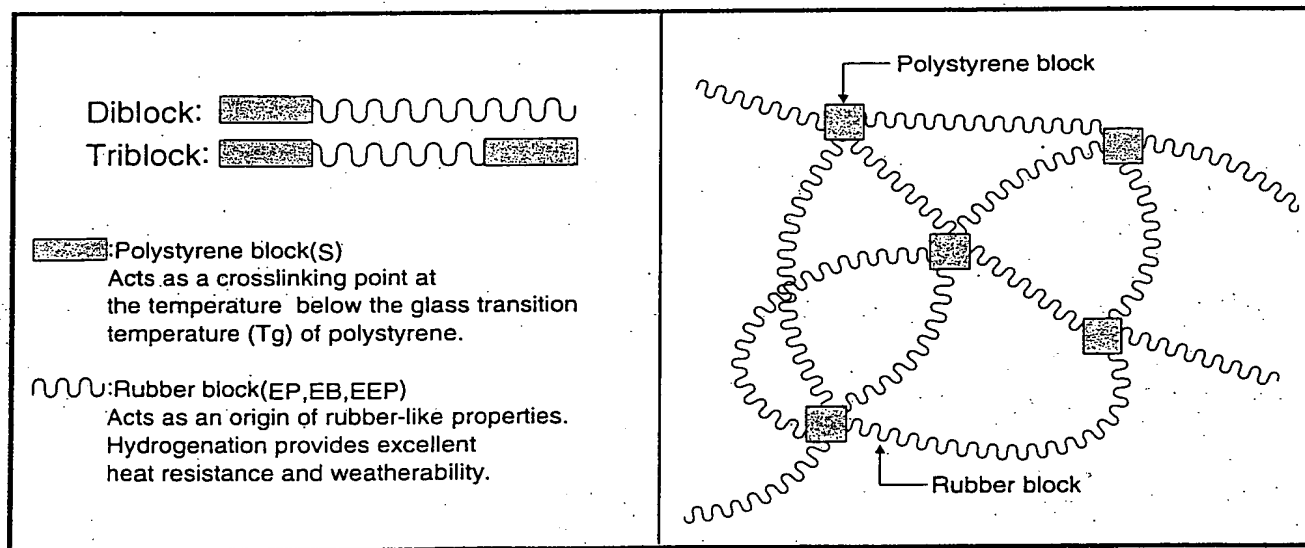
SEPTON® is a series of high performance thermoplastic rubbers developed by KURARAY CO., LTD. using its unique isoprene technology.

In terms of structure, SEPTON® is a series of hydrogenated styrenic block copolymers, and it exhibits rubber-like properties over a wide range of temperatures. Its remarkable characteristics are as follows:

- Excellent Mechanical Properties
- Good Weatherability
- Excellent Low Temperature Properties
- Excellent Electrical Insulation Properties
- Superior Heat Resistance
- Excellent Chemical Resistance
- Low Toxicity

Prior to processing, the polystyrene end blocks are associated in rigid domains. In the presence of heat and shear such as during processing, the polystyrene domains soften and permits flow. After cooling, the polystyrene domains reform and harden, locking the rubber network in place. This physical phenomenon provides SEPTON® with its high tensile strength and its elasticity. Since SEPTON® is a thermoplastic, it is recyclable.

Molecular Structure Model



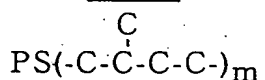
SEPTON[®]

Types and Properties

SEPTON[®] is available in either a diblock (A-B) type^{*1} or the more common triblock (A-B-A) types.^{*2, *3, *4}

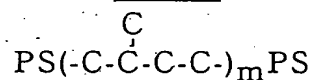
Several types of hydrogenated styrenic block copolymers of SEPTON are a hydrogenated poly(styrene-b-isoprene) (SEP)^{*1}, a hydrogenated poly(styrene-b-isoprene-b-styrene) (SEPS)^{*2}, a hydrogenated poly(styrene-b-butadiene-b-styrene) (SEBS)^{*3} and a hydrogenated poly(styrene-b-isoprene/butadiene-b-styrene) (SEEPS)^{*4}. Each type of polymers has its own set of unique properties.

SEP^{*1}



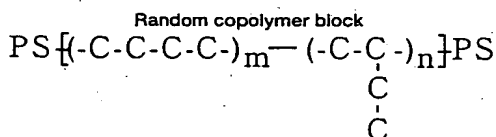
- Good Flowability

SEPS^{*2}



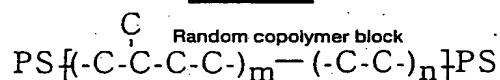
- No Crystallization
 - Better Low Temperature Properties
- High Elongation

SEBS^{*3}



- Moderate Tensile Strength

SEEPS^{*4}



- High Tensile Strength
- Moderate Elongation
- Better Oil Absorbency

*1 Polystyrene-b-poly(ethylene/propylene)

*2 Polystyrene-b-poly(ethylene/propylene)-b-polystyrene

*3 Polystyrene-b-poly(ethylene/butylene)-b-polystyrene

*4 Polystyrene-b-poly(ethylene-ethylene/propylene)-b-polystyrene

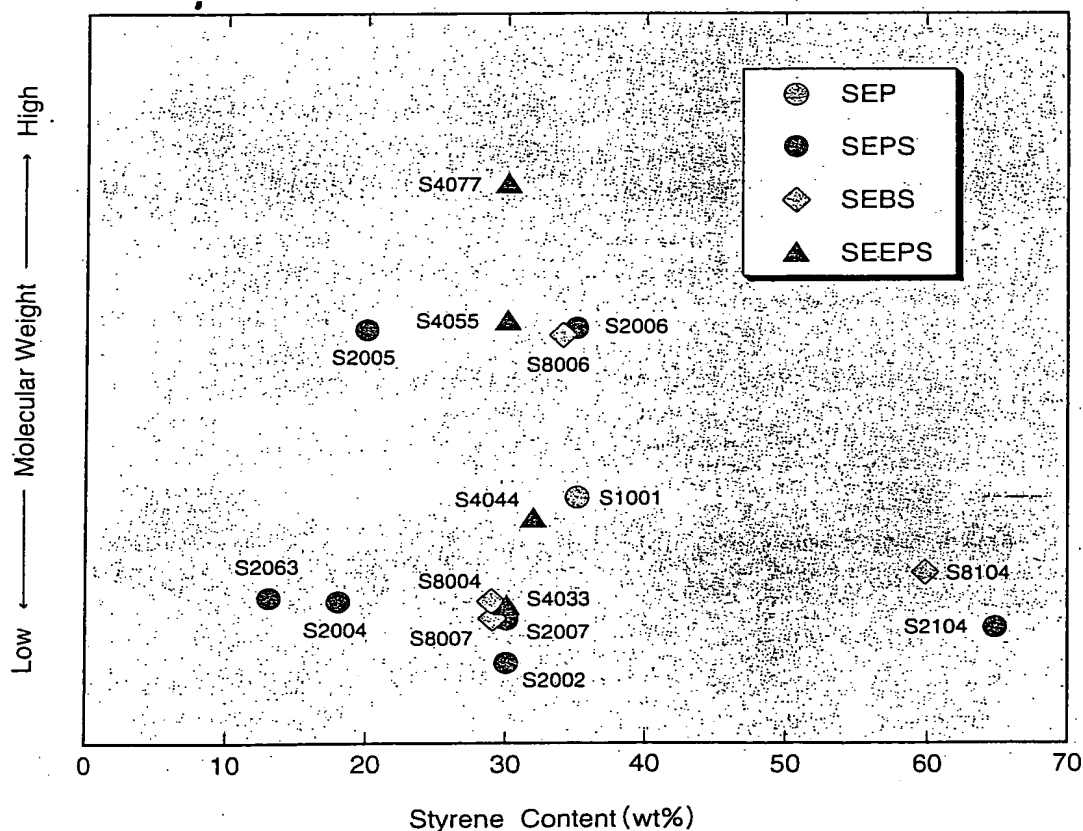
SEPTON®

High Performance Thermoplastic Rubber

SEPTON® is offered in a variety of grades as shown below:

- SEP : Polystyrene-b-poly(ethylene/propylene)
- SEPS : Polystyrene-b-poly(ethylene/propylene)-b-polystyrene
- SEBS : Polystyrene-b-poly(ethylene/butylene)-b-polystyrene
- SEEPS : Polystyrene-b-poly(ethylene/ethylene/propylene)-b-polystyrene

SEPTON® Grade Map



An Aid in Selecting the Right SEPTON® Grade for Your Application

The following pages are intended to assist in the selection of the proper SEPTON® grade for a particular application. The properties shown are typical properties and should not be used to establish specifications. To obtain more specific information on a particular SEPTON® grade, contact your SEPTON® representative.

Application Selector Guide

	SEPTON® Grades																
	1000 Series	2000 Series								4000 Series				8000 Series			
	1001	2002	2004	2007	2005	2006	2063	2104	4033	4044	4055	4077	8007	8004	8006	8104	
Polymer Modification																	
Adhesives/Sealants/Coatings																	
Wire & Cable Coatings																	
Viscosity Improver																	
Compatibilizer																	
General Compounding																	

Certain grades may be used for FDA approved applications.
Contact your SEPTON® representative for specific.

SEPTON® High Performance Thermoplastic Rubber

These are typical values and should not be used to set specifications.

Property Type		1001	2002	2004	2007	2005	2006	2063
		SEP	SEPS	SEPS	SEPS	SEPS	SEPS	SEPS
Styrene Content	wt%	35	30	18	30	20	35	13
Specific Gravity		0.92	0.91	0.89	0.91	0.89	0.92	0.88
Hardness	shore A	80	80	67	80	—	—	36
Tensile Property								
100% Modulus	MPa		3.2	2.2	3.0	—	—	0.4
Tensile Strength	MPa	2	11.2	16	16.7	—	—	10.8
Elongation	%	<100	480	690	580	—	—	1200
MFR								
230°C, 2.16kg	g/10min	0.1	70	5	2.4	No Flow	No Flow	7
200°C, 10kg	g/10min	1	100		4	No Flow	No Flow	22
Solution Viscosity								
5wt%	mPa·s					40	27	
10wt%	mPa·s	70			17	1700	1220	29
15wt%	mPa·s	1220	25	145	70			140
Physical Form ¹⁾		Pellet	Pellet	Pellet	Pellet	Powder	Powder	Pellet

¹⁾ Precautions should be taken in handling and storing.
Refer to the appropriate Material Safety Data sheet for further safety information.

In using SEPTON®, please confirm related law and regulations, and examine its safety and suitability for the application.

For medical and health care applications, please contact your SEPTON® representative for specific recommendations.

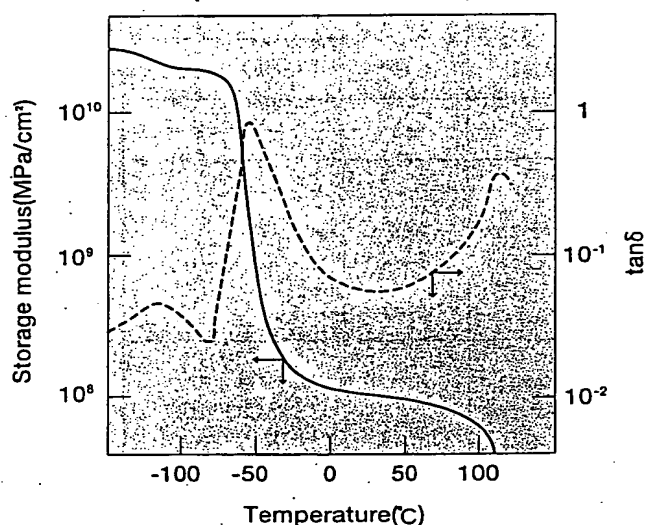
(Tested by KURARAY CO., LTD.)

2104	4033	4044	4055	4077	8007	8004	8006	8104	Measurement Method
SEPS	SEEPS	SEEPS	SEEPS	SEEPS	SEBS	SEBS	SEBS	SEBS	
65	30	32	30	30	29	29	33	60	
0.98	0.91	0.91	0.91	0.91	0.91	0.91	0.92	0.97	ISO 1183
98	76	—	—	—	80	80	—	98	ISO 48
4.3	2.2	—	—	—	2.3	2.3	—	12.9	ISO 37
<100	35.3	—	—	—	20.6	31.6	—	32.8	
	500	—	—	—	560	560	—	500	
0.4	<0.1	No Flow	No Flow	No Flow	1	<0.1	No Flow	—	ISO 1133
22	<0.1	No Flow	No Flow	No Flow		<0.1	No Flow	1	
23	50	22	90	300	25	40	42	80	Toluene solution 30°C
	390	460	5800						
Pellet	Powder	Powder	Powder	Powder	Pellet	Powder	Powder	Pellet	

SEPTON® Basic Characteristics

(Test Data from KURARAY CO., LTD.)

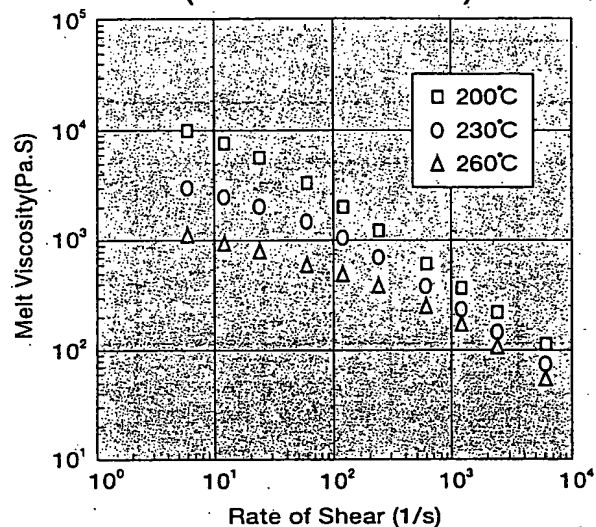
Dynamic Viscoelastic Behavior (SEPTON® 2007)



Test Conditions:

Aparatus: Dynamic Rheometer "REOVIBRON DDV-III"
Tensile mode
Heating Rate: 3°C/min
Frequency: 11Hz

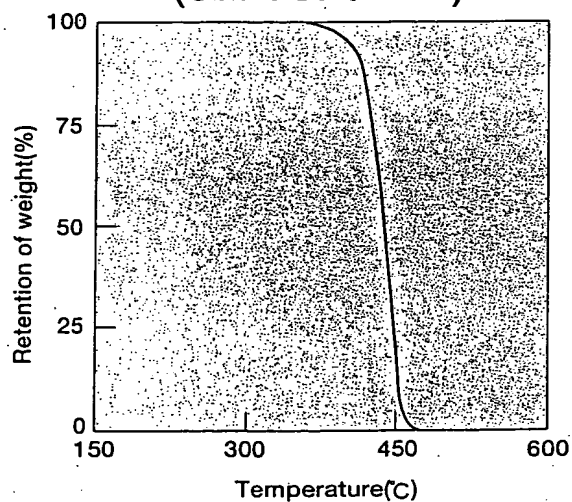
Capillary Flow Test (SEPTON® 2007)



Test Conditions:

Aparatus: Capillary Rheometer "CAPIRO GRAPH"

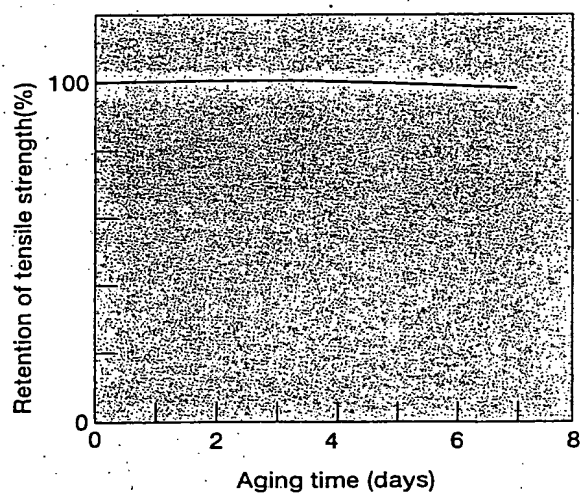
Heat Resistance (SEPTON® 2007)



Test Conditions:

Thermobalance Heat Degradation
Heating Rate: 10°C/min
Nitrogen Atmosphere

Heat Aging Resistance (SEPTON® 2007)



Test Conditions:

Geer Oven at 120°C

SEPTON® Basic Characteristics

(Test Data from KURARAY CO., LTD.)

Electrical Properties (SEPTON® 2063)

Item	Grade	2063
Dielectric Constant	50Hz	2.31
	10 ³ Hz	2.31
	10 ⁶ Hz	2.31
Dielectric Loss Tangent	50Hz	0.0002
	10 ³ Hz	0.0002
	10 ⁶ Hz	0.0008
Dielectric Breakdown Voltage	kV/mm	23.0
Volume Resistivity	Ω·cm	3.0×10 ¹⁶

Test Conditions: JIS K-6911-Dielectric Breakdown Voltage: Voltage Rising Rate = 1kV/sec
 Electrode 25 mm ϕ plate (measured in insulating oil)
 Volume Resistivity: Measured 1min. after applying DC500V @ 20°

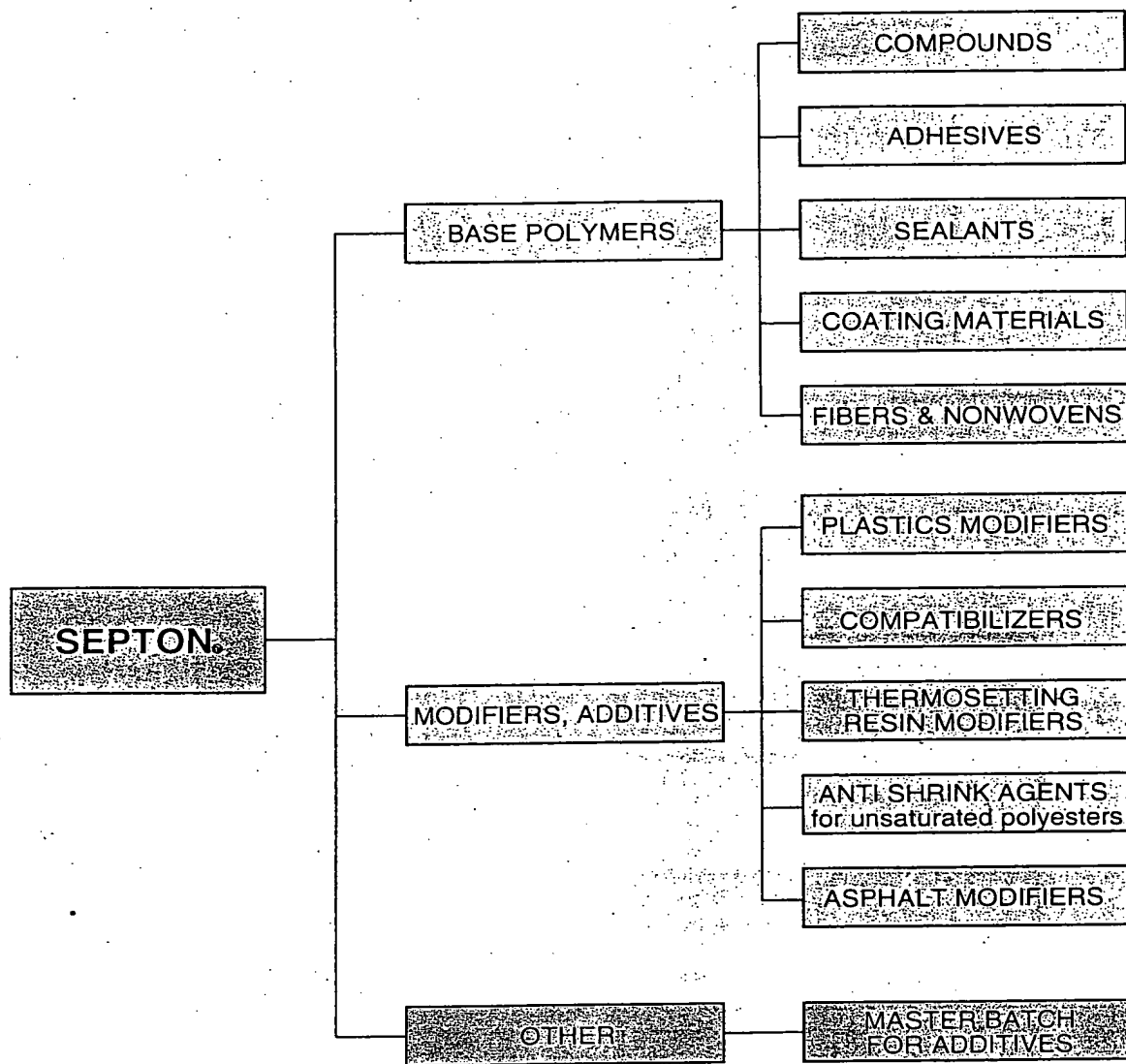
Combustion Test (SEPTON® 2002)

	Amount Formed (mg/g)	Detection Limit (mg/g)
Combustion Gas		
SOx(reduced to SO ₂)	not detected	1
NOx(reduced to NO ₂)	not detected	1
HCl	not detected	0.05
HCN	not detected	0.005
NH ₃	not detected	0.05
CO	1.1	0.5
CO ₂	2,900	20
Gross Calorific Value	Cal/g	10,800

Test Conditions: Combustion gas was analyzed in accordance with JIS K-7217
 Gross Calorific Value: Nekken type automated gas cylinder calorimeter

SEPTON® Applications

Due to their excellent balance of properties and versatility, SEPTON® polymers are applied to a wide variety of uses as can be seen below.



The following are examples of typical formulations or polymer modification where SEPTON® polymers provide high performance at an economical cost.

SEPTON® Applications

Compounds

When blended with a polyolefin and a process oil, SEPTON® provides a soft compound that is a suitable replacement for vulcanized rubber and soft PVC.

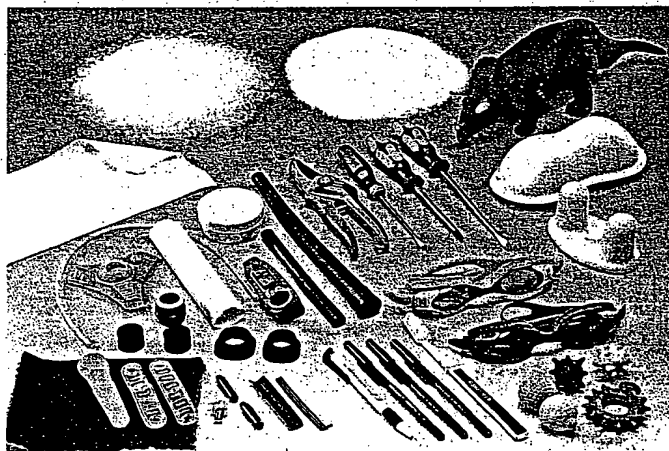
(test data from KURARAY CO., LTD.)

		1	2	3
Formulation				
SEPTON® 4055		100	100	100
Polypropylene		75	50	25
Process Oil		120	120	120
Anti Oxidant	(parts by wt.)	0.3	0.3	0.3
MFR 230°C, 2.16kg	g/10min.	10	2.9	0.1
Hardness	JIS A	76	64	45
Mechanical Properties				
100% Modulus	MPa	3.1	2.2	0.9
300% Modulus	MPa	4.2	3.1	1.6
Tensile Strength	MPa	15.2	10.8	7.4
Elongation	%	790	790	850
Permanent Set (100% @ 10min.)	%	16	10	5
Compression Set (70°C @ 22hrs)	%	48	39	29

Mixing Condition: Twin Screw Extruder, 230°C, 200rpm.

(1MPa=10.20kgf/cm²)

Molding Condition: Injection Molding



Examples of practical use of SEPTON® compounds

SEPTON® Applications

Adhesives

Due to their excellent balance of properties and versatility, SEPTON® polymer are applied to a wide variety of uses as can be seen below.

SEPTON® Solubility

Poor or Non Soluble In : Ethyl Acetate, Methyl Ethylketone,
Methanol, Ethanol, Acetone, Water

Soluble : Petroleum Ether, Toluene, Benzene,
Hexane, Cyclohexane

Tackifiers Compatible with SEPTON®

Rubber Phase: Alicyclic Saturated Hydrocarbon Resins,
Hydrogenated Terpene Resins,
Petroleum Resin, Hydrogenated Rosin Resin

Hot melt Adhesives

(tested by Kuraray Co., Ltd)

	1	2	3	4
SEPTON® 2063	100	100	100	
SEPTON® 2004				100
Tackifier	300	250	200	300
Paraffinic Process Oil (parts by wt.)	100	100	100	100
Rolling Ball Tack Test	3	18	22	<2
Creep Test Holding Power (min)	90	104	105	>240
Slippage (mm)				6.5
Peel Test To Stainless Steel (g/cm)	1200	1000	740	1380
To PE (g/cm)	1090	840	480	500
Melt Viscosity 160°C (mPa·s)	3250	4280	5600	4700

TEST Conditions : Coating Thickness 30μm

Rolling Ball Tack Test: Measured at 25°C

Creep Test: Load 1kg at 40°C, Sample Size 25mm×25mm

Peel test: 180° Peel test Rate of Peel 300mm/min at 25°C

Melt Viscosity: Brook field viscometer

SEPTON® Applications

Plastics Modification

When blended with olefinic polymers, SEPTON® improves various properties including impact strength. SEPTON® can also act as a compatibilizer between polyolefins and polystyrenics.

Polypropylene Modification

(test data from KURARAY CO., LTD.)

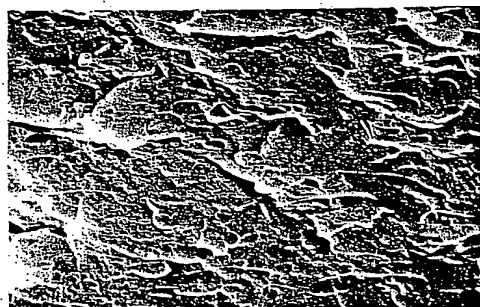
		1	2	3	4
PP (Block copolymer)		100	80	80	80
SEPTON®2004			20		
SEPTON®2007				20	
EPR					20
Izod Impact strength					
25°C	(J/m)	117	614	547	164
-20°C	(J/m)	38.5	141	122	90
Flexural Modulus	(MPa)	752	572	671	656
Flexural Strength	(MPa)	23.3	18.3	19.3	18.3

Compatibilizer

(test data from KURARAY CO., LTD.)

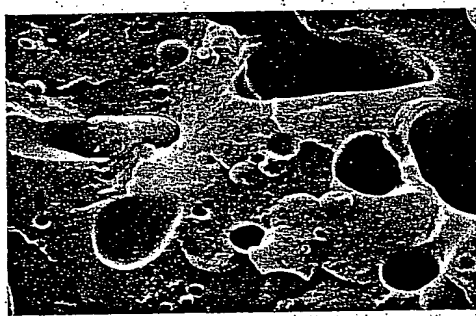
		1	2
ABS		70	70
PP		30	30
SEPTON®2104	(parts by wt.)	5
Izod Impact Strength			
Notched 25°C	J/m	49	88
Unnotched 25°C	J/m	167	549
Flexural Modulus	MPa	2040	1980

(1MPa = 10.20kgf/cm²)
(1 J/m = 0.102kgf·cm/cm)



ABS/PP/SEPTON® Blend

1μm



ABS/PP Blend

1μm

Scanning Electron Micrograph(X1000)



KURARAY CO., LTD. :Kuraray Nihonbashi Bldg., 3-1-6, Nihonbashi, Chuo-ku, Tokyo 103-8254

PHONE: +81-3-3277-6655, FACSIMILE: +81-3-3277-6718

SEPTON Company of America :11414 Choate Road, Pasadena, TX 77507

PHONE: +1-281-909-5850, FACSIMILE: +1-281-909-5851

KURARAY EUROPE GMBH :Schiess-Strasse 68, 40549 Düsseldorf

PHONE: +49-211-53888-39, FACSIMILE: +49-211-53888-48

This information contained in this booklet is, to the best of our knowledge, true and accurate. However, since conditions of use are beyond our control, all recommendations or suggestions are presented without guarantee or responsibility on the part of Kuraray Co., Ltd., SEPTON Company of America or Kuraray Europe GmbH. We disclaim all liability in connection with the use of information contained herein or otherwise. All risks of such use are assumed by the user. Furthermore, nothing contained herein shall be construed as an inducement or recommendation to use any process or to manufacture or to use any product in conflict with existing or future patents.



This is printed with eco-friendly vegetable soy ink.



This is a print of recycled paper.

1st Ed. 1993. 5 E
2nd Ed. 1994. 4 E
3rd Ed. 1995. 8 E
4th Ed. 1999. 4 E
5th Ed. 2001. 8 E
6th Ed. 2001. 10 E
7th Ed. 2002. 9 E-2